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Abstract

Neuromuscular electrical stimulation (NMES) may be used to prevent atrophy and strength loss associated with post-surgical immobilization. A number of studies have tested the effectiveness of NMES using primarily knee extensors. The purpose of this investigation is to test the effectiveness NMES when training the elbow flexors by comparing NMES to voluntary training.

Twenty-four university students were assigned with a counter-balanced design to one of three groups: NMES training, voluntary training, or a control group that did not train. Testing and training sessions were completed using a Biodex™ dynamometer. After a standard warm-up, subjects were positioned on the Biodex™ with the shoulder in the anatomical neutral position, elbow flexed to 90° and forearm supinated. Subjects performed three maximum isometric muscle actions of five-second duration with one minute of recovery between repetitions. Average peak torque during three repetitions was used in the analysis. Subjects then trained on three days per week for four weeks.

Each training session included 15 maximum isometric muscle actions of ten-second duration with 50-second recovery between repetitions. NMES was provided by a Forte™ 400 Combo (Chattanooga Group, Inc., Hixon, TN). Russian current was delivered via two carbon rubber electrodes placed over the proximal and distal ends of the left biceps brachii. A maximum tolerable ramped intensity was delivered with a frequency of 90 burst per second and a duty cycle of 10:50.

After four weeks of training, subjects were post-tested in a manner identical to the pretest. Mean normalized strength data were analyzed using a 3 (Group) x 2 (Test) analysis of variance with repeated measures on the last factor. The analysis revealed a significant main effect for Test [$F(1,21)=15.14$, $p<0.001$)] with means of .48 and .59 for the pre and post-test, respectively. The main effect for Group was not significant [$F(2,21)=1.30$, $p>0.2$)]. The Group x Test interaction was significant [$F(2,21)=4.62$, $p<0.02$)].

Post-hoc analyses revealed that the voluntary training group had a significantly greater increase than the other two groups, which did not vary significantly from one another. The lack of significant strength gains with NMES was likely due to the low average training intensity, which was only 20.4 % of the MVIC. Based on the results of this study, NMES training under these conditions may not be an effective alternative to voluntary training.

Introduction

Neuromuscular electrical stimulation (NMES) is recommended to prevent atrophy and strength loss associated with post-surgical immobilization. NMES has been reported as an effective alternative when voluntary contractions against resistance are not possible. A number of studies have tested the effectiveness of NMES with the knee extensors used almost exclusively as the test muscle. The purpose of this investigation is to test the effectiveness of NMES when training the elbow flexors by comparing NMES to voluntary training.

Methods

Subjects

Twenty-four male (11) and female (13) university students volunteered to participate in this study.

Age	23.5 ± 3.9 yr
Height	1.73 ± .12 m
Weight	73.1 ± 16.7 kg

Procedures

Subjects were assigned using a counter-balanced method to one of three groups: NMES training, voluntary training, or a control that did not train. Both testing and training sessions were completed using a Biodex™ dynamometer. After a standard warm-up, subjects were positioned on the Biodex™ with the shoulder in the anatomical neutral position, elbow flexed to 90° and forearm supinated. Subjects performed three maximum isometric muscle actions of 5-second duration, with 1-minute rest between repetitions. The average peak torque during three repetitions was used in the analysis.

Subjects then trained three days per week for four weeks. Each training session included 15 maximum isometric muscle actions of 10-second duration with 50-second recovery between repetitions. A Forte™ 400 Combo (Chattanooga Group, Inc., Hixon, TN) was used to provide NMES. Russian current was delivered via two carbon rubber electrodes placed over the proximal and distal ends of the left biceps brachii. A maximum tolerable ramped intensity was delivered with a frequency of 90 burst per second and a duty cycle of 10:50. After four weeks of training, subjects were post-tested in a manner identical to the pretest. Mean strength data normalized for body weight were analyzed using a 3 (Group) x 2 (Test) analysis of variance with repeated measures on the last factor.

Results

Pretest to Post-test normalized torque for each training group was included in the analysis. The statistical analysis revealed a significant main effect for Test [$F(1,21)=15.14$, $p<0.001$)] with means of .48 and .59 for the pre and post-test, respectively. The main effect for Group was not significant [$F(2,21)=1.30$), $p>0.2$)]. The Group x Test interaction was significant [$F(2,21)=4.62$), $p<0.02$)]. Post-hoc analyses revealed that the voluntary training group had a significantly greater increase than the other two groups, which did not vary significantly from one another.

Conclusions

The lack of significant strength gains with NMES was likely due to the low average training intensity, which was only 20.4 % of the MVIC. Based on the results of this study, NMES training under these conditions may not be an effective alternative to voluntary training.